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Reorienting the HIV Response in Niger Toward Sex Work Interventions: From Better Evidence to Targeted and Expanded Practice

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Background: Niger's low-burden, sex-work-driven HIV epidemic is situated in a context of high economic and demographic growth. Resource availability of HIV/AIDS has been decreasing recently. In 2007–2012, only 1% of HIV expenditure was for sex work interventions, but an estimated 37% of HIV incidence was directly linked to sex work in 2012. The Government of Niger requested assistance to determine an efficient allocation of its HIV resources and to strengthen HIV programming for sex workers.

Methods: Optima, an integrated epidemiologic and optimization tool, was applied using local HIV epidemic, demographic, programmatic, expenditure, and cost data. A mathematical optimization algorithm was used to determine the best resource allocation for minimizing HIV incidence and disability-adjusted life years (DALYs) over 10 years.

Results: Efficient allocation of the available HIV resources, to minimize incidence and DALYs, would increase expenditure for sex work interventions from 1% to 4%–5%, almost double expenditure for antiretroviral treatment and for the prevention of mother-to-child transmission, and reduce expenditure for HIV programs focusing on the general population. Such an investment could prevent an additional 12% of new infections despite a budget of less than half of the 2012 reference year. Most averted infections would arise from increased funding for sex work interventions.

Conclusions: This allocative efficiency analysis makes the case for increased investment in sex work interventions to minimize future HIV incidence and DALYs. Optimal HIV resource allocation combined with improved program implementation could have even greater HIV impact. Technical assistance is being provided to make

the money invested in sex work programs work better and help Niger to achieve a cost-effective and sustainable HIV response.

Key Words: sex work, HIV incidence, impact, mathematical modeling, allocative efficiency, resource optimization, program science

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INTRODUCTION

Niger's HIV epidemic is concentrated in high-risk populations including female sex workers (FSWs), among whom HIV prevalence (17.3% in 2011) is more than 40 times higher than the general female population.¹ Overall population HIV prevalence is one of the lowest in West and Central Africa,² however, and only 1.4% of all years of life lost in Niger are attributed to HIV/AIDS.³ The top drivers of health loss are other communicable diseases such as lower respiratory infections, diarrheal diseases, malaria, meningitis, measles, and tetanus, as well as protein–energy malnutrition.⁴ Premature mortality, death rates, and poverty levels have been decreasing over the last decade. Economic growth reached 11% in 2012.⁵ However, despite progress, Niger remains one of the poorest countries in the world with a per capita gross domestic product (GDP) of USD 440 in 2013. The high population growth rate (3.9%, average intercensal 10-year rate) puts considerable strain on services and resources. If this continues, the population will double every 23 years.

Contextual factors influence Niger's HIV epidemic trajectory. The epidemic is concentrated in urban areas, where the population is increasing by about 6.2% annually. The availability of jobs in the mining, petroleum, and infrastructure development sectors, along with other new economic opportunities, encourage migration and mobility, which create risk contexts for HIV. Survey data from 2012 show a link between men's sexual risk behaviors and mobility and being away from home.⁶ With improved income levels and better availability of disposable income, it is likely that risk behaviors such as paying for sex become more widespread. In men, HIV infection is clustered in the wealthiest; HIV prevalence among those in the highest 2 wealth quintiles (0.6%) is 6 times higher than men in the lower 3 wealth quintiles (0.1%).⁵ In addition, a greater proportion of the wealthiest men (highest quintile) are likely to report having paid for sex (2.9%) compared with the poorest men (lowest

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quintile) (0.6%).⁷ Meanwhile, a chief protective factor for HIV risk—school education—has shown stagnation in Niger. In 2012, HIV prevalence was lowest in the most educated population segment at 0.1% in men and 0.2% in women.⁵

Niger was among 9 West African beneficiary countries of a support program financed by the Canadian International Development Agency, of which the third phase (SIDA-3, 2001–2006) promoted an integrated approach to service provision for FSWs, their clients, and partners.⁸ The country's HIV response has been heavily reliant on external financing, which accounted for almost 90% of HIV spending in the 5 National AIDS Spending Assessment (NASA) years of 2007–2011.^{9,10} Although public sector HIV spending increased in 2012, because of a World Bank loan that is counted as domestic funding, the share of internally mobilized funding from national revenue streams remained low. The average annual cost of the national HIV response (2007–2012 data) was USD 12.6 million or 0.24% of GDP. Furthermore, there has been a substantial decline of investment in sex worker services because the regional bilateral cooperation project SIDA-3 ceased in 2007.¹¹ In 2012, only 0.9% of total HIV prevention spending was for FSW interventions. The majority of FSW-directed funding comes from international sources. This raises questions on prioritization, sustainability, and ownership of the sex work-related response.

This article summarizes the HIV epidemic and response situation in Niger with a focus on FSW, including modeled trends using Optima (Kerr CC, Stuart RS, Gray RT, et al, accepted for publication, *J Acquir Immune Defic Syndr*, 2015). It then presents new evidence on different resource allocation scenarios and the projected impact on the HIV epidemic. Based on the epidemic and program implementation evidence, it discusses possible ways forward to increase the efficiency and effectiveness of HIV investments targeting sex workers in Niger. It draws lessons from Niger's experiences and the program science approach¹² used in sex work-related responses in India^{13,14} and Nigeria.

The analysis was implemented by the World Bank in collaboration with UNAIDS based on a request for analytical support in HIV resource allocation and prioritization from the Government of Niger.

METHODS

We conducted a data review using published and unpublished reports of surveys and studies, government documents on HIV and health strategy, expenditure, budgets, resource mapping, and service delivery. Several stakeholder meetings helped to refine the modeling and collect qualitative information about FSW interventions.

Optima, a deterministic mathematical model for HIV optimization and prioritization, was applied to local epidemiologic, demographic, programmatic, expenditure, and cost data.⁹ Optima (originally called Prevtool) was developed in 2010 as an alternative to existing epidemiologic models, which are typically restricted in terms of the population groups and interventions available. Optima has been used in numerous countries for allocative efficiency analyses (for a full list, see <http://optimamodel.com>) (Wilson DP, Shattock AJ, Kerr CC, et al, unpublished data, October 2014). The unique feature of

the tool is its mathematical optimization algorithm that helps determine the most efficient resource allocation mix for meeting a certain objective, such as reducing the greatest number of new infections for a given amount of funding or reaching predefined HIV incidence targets for the lowest possible spending. The model uses best-practice HIV epidemic modeling techniques and incorporates realistic biological transmission processes, detailed infection progression stages, sexual mixing patterns, and sexual and HIV service use behaviors, as described in the Technical Appendix (see **Supplemental Digital Content**, <http://links.lww.com/QAI/A599>).

Informed by available HIV surveillance data, the model included 14 distinct populations: FSWs, men who have sex with men (MSM), labor migrants, uniformed security, mine workers, truckers, prisoners, and 7 subgroups of the low-risk general population (children aged 0–14 years; females aged 15–24, 25–49, and 50+ years; and males aged 15–24, 25–49 and 50+ years). Because of small estimated population sizes, MSM, labor migrants, uniformed security, mine workers, truckers, and prisoners were grouped into a higher-risk key population (KP). The only size estimate available for MSM at country level was 10,000, which we used in the model.¹⁵ Expenditures were classified into (1) those expenditure categories with evidence of HIV impact, included in the optimization [prevention package for FSWs consisting of condom promotion, HIV counseling and testing (HCT), community mobilization activities sometimes including peer approaches; prevention package for KPs consisting of condom promotion, HCT, and risk reduction communication; prevention services for the general population consisting of HCT and risk reduction communication; public sector condom distribution; social marketing of condoms; prevention of mother-to-child transmission of HIV (PMTCT); antiretroviral treatment (ART)] and (2) those expenditure categories without direct HIV impact, not included in the optimization (support to orphans and vulnerable children, blood screening, postexposure prophylaxis, medical waste management, and response management and coordination). HCT was part of the HIV prevention, ART, and PMTCT service packages; and PMTCT included community mobilization activities. Drug costs were kept constant over time, whereas other costs increased in line with GDP per capita.

The 2012 programmatic spending pattern was used as the reference in the optimization analysis.⁸ It was assumed that the funds acquired by the end of 2013 for the 4 remaining years of the National Strategic Plan would be available at an annual average of USD 6.5 million until 2017 and that program coverage would be maintained thereafter in the long-term projections. Local data were used to formulate evidence-based assumptions on the relationship between funding, HIV outcomes, and program coverage. The Technical Appendix (see **Supplemental Digital Content**, <http://links.lww.com/QAI/A599>) presents the model calibration and the cost–outcome curves.

The optimization function was run by combining the information on the relationship between costs and outcomes with a simple optimization algorithm that found the best allocation of resources to meet the objective of either minimizing HIV incidence or disability-adjusted life

years (DALYs) until 2024. Optima was used to project epidemic trajectories according to the counterfactual scenarios, and comparison of these trajectories with the calibrated epidemic trajectory according to actual conditions resulted in an estimation of the impact of the HIV program.

To incorporate uncertainty, model results were calculated using a Markov Chain Monte Carlo method, as described in the Technical Appendix (see **Supplemental Digital Content**, <http://links.lww.com/QAI/A599>). However, because of the difficulties involved in obtaining reliable and sufficient data to calculate formal statistical uncertainty bounds with respect to the cost–outcome relationships of HIV programs, the allocative efficiency results instead indicate maximum-likelihood estimates.

RESULTS

The Epidemiology of HIV in Sex Workers in Niger

There are an estimated 28,000 FSWs in Niger.¹⁵ A recent geographic mapping activity in 4 of the 8 regions only identified 3200 FSWs, however, because of the stigma attached to—and thus the hidden nature of—sex work.^{16,17} HIV prevalence in FSWs has been declining; 25.6%, 20.9%, and 17.3% of FSWs tested positive in surveys in 2002,¹⁸ 2008,¹⁹ and 2011,¹ respectively. The rates of infection also decreased in FSW client populations (security and defense forces: 3.8% in 2002 to 0.4% in 2011; truckers: 1.8% in 2008 to 0.4% in 2011; mine workers: 1.3% in 2008 to 0.4% in 2011). Similarly, HIV prevalence in the general adult population decreased from 0.7% in 2006 to 0.4% in 2012.⁵ We estimated that 37% of HIV incidence was directly linked to sex work in 2012.²⁰

HIV prevalence among FSWs in different administrative regions varied in 2011 between 0% and 31%, and cross-border movements between Niger and Nigeria are one explanatory factor.¹ Well over one-half of surveyed FSWs are divorced (and others widowed or separated), pointing to sex work as a livelihood option for vulnerable women. FSWs who have experienced violence are more than twice as likely to be HIV positive (32%) versus FSWs who have not experienced violence (14%).¹ HIV status by years of sex work suggests a rapid acquisition of HIV in the first few months of sex work, with street prostitution less safe than brothel-based work. It is plausible that some FSWs are already infected when taking up sex work, through rapid partner acquisition and transactional sex behaviors, as infected spouses of HIV cases, or through other HIV exposures. There are clues in survey data that other female subpopulations have high-risk sexual behaviors. Female defense and security personnel are much more likely to be HIV infected than their male colleagues (7.7% versus 0.1%), and similar increased HIV risk was observed among female teachers, prisoners, and labor migrants, compared with their male colleagues.¹

Recent mapping enumerated FSWs in bars, restaurants, night clubs, hotels, brothels, markets, tourist camps, and on the street.^{14,21} Sex workers younger than 30 years are more likely to work on the street, whereas brothels tend to include women

up to 50 years of age. The number of clients differs according to the type of site, with bars and restaurants having the highest proportions of FSWs serving over 20 clients a day. Client refusal of condom use is the main reason for unprotected commercial sex (responsible for 85% of all unprotected sex acts in a 2010 sex work study in Niamey²²). One study found that 72% of FSWs allow unprotected sex with clients who refuse to use condoms.²³ About 23% of FSWs report using a condom at every sexual act,²⁴ and the lowest rate of use is with nonpaying men described as boyfriends. This present analysis estimated a total of 2.3 million unprotected commercial sexual acts each year in Niger (compared with over 200 million sexual acts among regular sexual partners). In our modeling analysis, risk behaviors in the FSW population reflect average weighted values across different types of FSW.

HIV Programs and Services for Sex Workers in Niger

During the SIDA-3 project, FSW HIV prevention services and medical follow-up were provided by specialized adapted services. Since the end of SIDA-3 in 2007, the medical follow-up of sex workers has been the responsibility of the national sexually transmitted disease (STI) reference center. Service delivery decreased after SIDA-3 in a phase of integration and mainstreaming of services for FSWs. Although an estimated 75% of FSWs were reached with some prevention activities in 2008, only 54% were reached in 2011.¹ In the FSW medical follow-up offered in Niamey—which consists of screening and treatment services at a health center—only 41% of surveyed FSWs said they participate.²⁵ These are predominantly foreigners who enroll for administrative purposes. The package of FSW services is not well defined, except FSW peer education, which has an agreed content and delivery modalities.²⁶ However, the link between peer educators and clinic staff is weak, and planning of services is not based on current information on the dynamics of hotspots, FSW migration, and FSW site characteristics.

One component of the World Bank–supported HIV project²⁷ launched in 2012 is about strengthening the FSW-related HIV response. In several regions, NGOs have been contracted for survey, referral, and service delivery functions, and consultations at health centers are now free for FSWs in these areas. Barriers to using the health center, cited by FSWs in the mapping survey, are service costs, the geographic distance, the poor reception received, slowness of services, and lack of privacy. Also, stigma and the hidden nature of sex work prevent FSWs from seeking care. The HIV program has started to systematically define and characterize FSW typologies and sites, which represents indispensable strategic information toward tailoring services to the locality and needs.

Impact and Cost-effectiveness of Past HIV Investments

Using Optima, the impact of past HIV investments was estimated by comparing the expected number of new HIV infections according to actual intervention conditions with the estimated numbers under a counterfactual scenario of no funding for specific HIV programs. It was estimated that HIV

program spending from 2007 to 2012 averted close to 3900 infections during that period. By 2035, the prevention effect of these 6 years of program funding is projected to be much larger because of the downstream epidemiologic effects. A total of 12,600 infections are expected to have been averted by 2035. The estimated cost-effectiveness was USD 4700 per infection averted if only HIV program spending is considered, and USD 6200 if all HIV spending including management and coordination is included.

According to Optima, the largest HIV risk reduction occurred in FSW with annual HIV incidence of about 3.5% in 2000 declining to about 1.1% in 2012 (Fig. 1). FSW client populations have also seen significant HIV incidence declines and in 2012 experienced 1 new infection per 2000–3000 individuals. In the absence of other major programs being implemented, it is plausible that these HIV incidence reductions can in part be attributed to the combined effects of the regional SIDA-3 project and the Multisectoral STI/HIV/AIDS project 2003–2009 supported by the World Bank.²⁸ Important HIV incidence reduction is also thought to have occurred in MSM; however, data were very scarce for this population. Between 2000 and 2012, the HIV risk of prisoners also declined to about 1 new HIV infection annually for every 700 prisoners (ie, approximately 16 new HIV infections among Niger's roughly 11,600 prisoners). The general population has a very low risk of HIV infection. Optima estimates that in 2012, there was an average of 1 new

HIV infection for every 4200 women and for every 2900 men aged 25–49 years (lower risk in other age groups of men and women). Niger's 2014 Spectrum estimates showed similar HIV trends to Optima, and the government validated the outputs of both models.

Allocative Efficiency of Future HIV Investments in FSW HIV Programs

Optima's mathematical optimization feature allowed determination of the resource allocation to key programs most likely to minimize cumulative new HIV infections from 2014 to 2025. It was assumed that the funds acquired by the end of 2013 for the 4 remaining years of the National Strategic Plan (an average of USD 6.5 million annually from 2014 to 2017)²⁹ would be available up to 2017 and program coverage maintained thereafter.

According to Optima, the efficient share of resources for FSW interventions would be at least 4 times higher than in the current HIV response budget, increasing from 1% to 4%–5% (Figs. 2). More resources would also need to be allocated to ART (from 26% in 2012 to 48%) and PMTCT (from 11% in 2012 to 20%) to minimize incident infections up to 2025. Beneficiaries of investment in ART and PMTCT services also include FSWs, which therefore increase the overall investment in their favor. Allocations for HIV prevention in the general population would be much lower to make the other funding increases possible. Although the resource level used in this optimization analysis (USD 6.5 million) was significantly lower than actual expenditure in 2012 (USD 16.3 million), an additional 12% reduction in cumulative HIV incidence could be achieved from 2014 to 2025 if resources were allocated according to this split and level. Most of the incidence impact comes from increased funding for FSW (7000 extra infections averted across all population groups, counting direct and indirect/secondary transmission events). Reduced funding for general population programs would lead to about 3000 additional infections, but the net benefit was positive with 8900 additional HIV infections averted overall. For the objective of minimizing DALYs by 2025, the budget allocations were very similar to those associated with minimizing HIV incidence by 2025 (Fig. 2).

We also determined the most efficient allocation if the HIV response budget decreased. Even at only 20% of the USD 6.5 million budget, the funding allocations to FSW programs were completely preserved and are hence an utmost investment priority. The optimal funding allocated to the ART program when trying to minimize incidence—even when accounting for the high prevention efficacy of treatment³⁰—would decline more than proportionally if the budget fell below USD 6.5 million; many more new HIV infections would occur (Fig. 3), and AIDS cases would be denied treatment. With larger budgets above USD 6.5 million, more investment in PMTCT would help to further reduce HIV incidence, and for budgets above approximately USD 12 million, spending on HIV prevention programs for the general population could also be considered. The projected HIV incidence at different levels of HIV budget is shown in Figure 3.

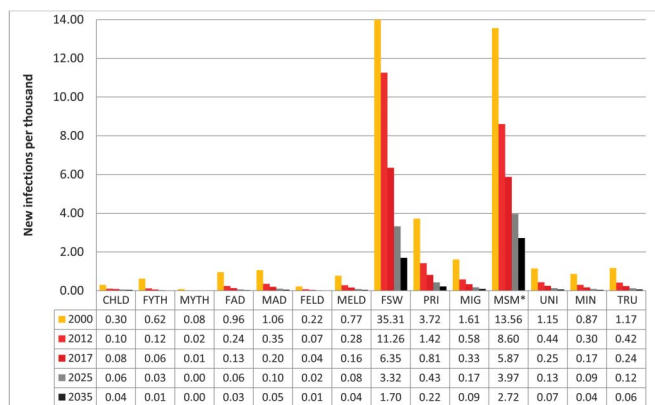


FIGURE 1. Estimated HIV infections by population and year in Niger (2000–2035). Estimations for MSM are based on assumed HIV prevalence data using information from the subregion and the resulting HIV incidence estimates for MSM are therefore uncertain. Sources: Niger epidemiological, demographic, behavioral, and service data in the populated Optima model. *HIV incidence estimates for MSM are indicative only because of insufficient data. Note: The y axis is truncated, HIV incidence in FSW in 2000 is not fully displayed. CHLD, children aged 0–14; FYTH, females aged 15–24; MYTH, males aged 15–24 years; FAD, females aged 25–49; MAD, males aged 25–49; FELD, females aged 50+; MELD, males aged 50+; PRI, prisoners; MIG, migrants; UNI, uniformed security/defence personnel; MIN, mine workers; TRU, truckers. Adaptations are themselves works protected by copyright. So in order to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.

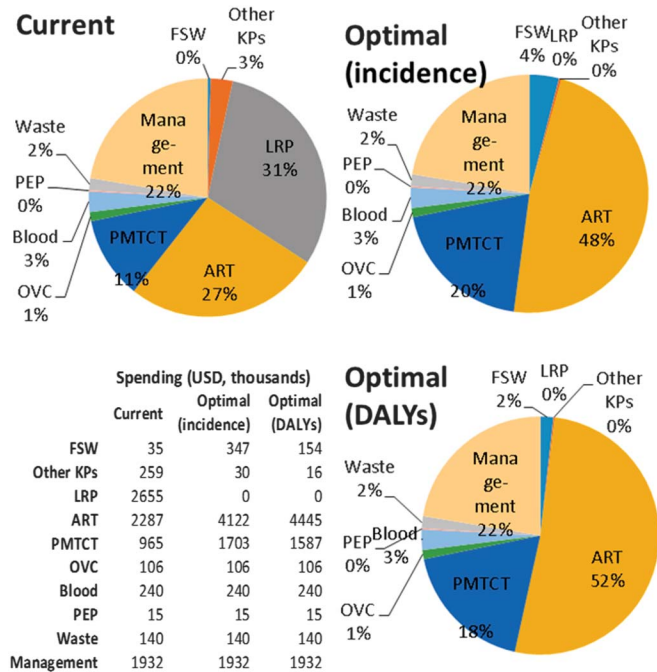


FIGURE 2. 2012 versus optimal budget allocations for minimizing HIV incidence and DALYs over the period 2014–2025. Sources: Spending data from NASA; Niger epidemical, demographic, behavioral, and service data in the populated Optima model. Note: “Current” = 2012 spending pattern. OVC, safe blood, PEP, waste, and management costs were kept fixed. Condoms are part of the HIV intervention packages for the different populations. Other KPs = A combined group of KPs, including prisoners, migrants, men having sex with men, uniformed security/defense personnel, mine workers, and truckers; LRP = A combined group of low-risk populations, consisting of females and males aged 15 years and above. Adaptations are themselves works protected by copyright. So in order to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.

Strengthening the Design and Implementation of FSW Interventions to Make the Money Work

Based on the allocative efficiency analysis, 4–5 times more resources should be spent on providing services for FSW compared with the 2012 reference year. But, additional resources will only deliver the anticipated HIV impact if the intervention can be scaled effectively and service quality be ensured across sites, providers, and administrative regions. Working with key informants and reviewing the available FSW program data and service delivery statistics, we explored the strengths, programming gaps, and opportunities of Niger’s FSW interventions. We found that there are good practices that can be built on: The peer-led outreach education in 4 regions (Niamey, Maradi, Tahoua, and Zinder) increases sex workers’ risk perception for HIV and STIs and promotes the screening services offered by health centers. A coupon system provides free-of-charge access to

STI services, which are recorded in a booklet. Condoms and lubricant gel are being promoted, and HIV testing is offered to sex workers every 3 months with positive cases referred for treatment. There is some experience with geographic mapping and size estimation of sex workers which can be built on. We also believe that some of the increased spending for FSW interventions should be used for advocacy and structural interventions—linked to the service package for sex workers—to address stigmatization and discrimination preventing health service use and to strengthen their human rights context.

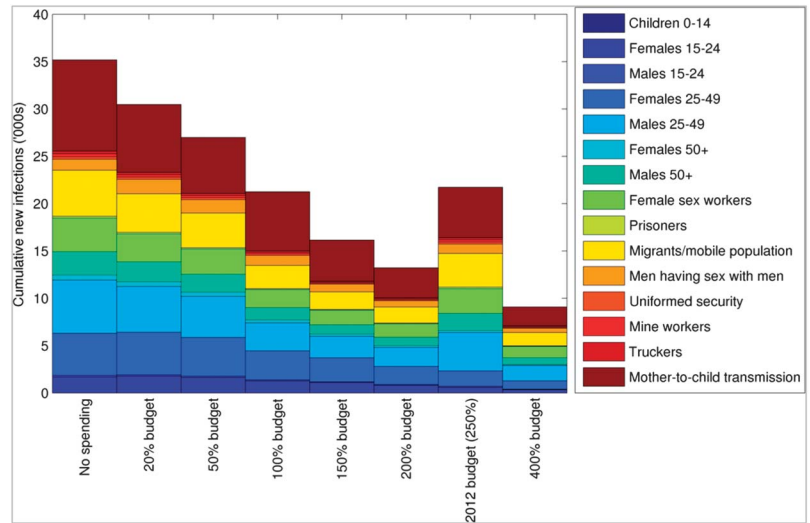
Regarding program implementation, the application and quality assurance of a standard service package is still weak, although there is local expertise on the provision of a comprehensive service package from the SIDA-3 implementation. Also, the unit cost of the FSW service package in Niger is nearly 3 times higher than for the comparison countries Togo and Democratic Republic of the Congo.³¹ Further reduction in cost of the FSW service package can be explored through improved, targeted, and expanded service delivery. ART initiation and adherence support for HIV infected sex workers should become a priority. Niger could also improve health care by strengthening linkages between the sex worker prevention program and reproductive health services, including PMTCT. Program evaluation and learning would be facilitated if program and financial monitoring is harmonized across providers in the public and NGO sectors. Building alliances with the police, community leaders, and opinion makers needs to be nurtured to create a conducive environment for universal access of Nigerien and foreign sex workers to HIV and health services.

DISCUSSION

This article addresses 2 important issues: The inadequate resource allocation to FSW programs (a critical reason why HIV prevention coverage remains low in this priority population) and the gaps in actual FSW program design and implementation (leading to missed opportunities and sub-optimal impact). In Niger, both issues are being systematically addressed. This involved an allocative efficiency and sustainability study in 2013, a World Bank credit for targeted HIV interventions and the provision of a tailored multiagency technical assistance package starting in 2014.

In Niger’s highly concentrated HIV epidemic, efficient and effective FSW programs hold the key to a HIV response, which is manageable and sustainable. Several cofactors of the epidemic—increased migration and mobility, growing income levels, and urbanization—could fuel the sex industry and counteract the encouraging reductions in HIV incidence. Granting better access of people living with HIV to ART is a priority, and so is the provision of client-centered ART adherence monitoring and support to ensure viral suppression. No systematically collected viral load data are available from Niger’s ART program, but data from Côte d’Ivoire suggest that 40% of monitored ART patients had detectable virus.³² This highlights the need for investment in the ART program for scale, efficiency, and quality, and our optimization analysis indeed suggested increased investment in this priority program.

FIGURE 3. Cumulative HIV infections over 2013–2025 resulting from different spending scenarios (no spending, a continuation of 2012 funding levels using 2012 resource allocation patterns (2012 budget), and model-optimized resource allocation patterns at various funding levels relative to expected funds available 2014–2017). Sources: Spending data from NASA; Niger epidemic, demographic, behavioral, and service data in the populated Optima model. Note: 2012 budget = 2012 expenditure pattern, for a total of USD 16.3 million. 100% budget = USD 6.5 million per year, based on acquired funding by end 2013. Drug costs are kept constant over time and other costs increase in line with GDP per capita. Adaptations are themselves works protected by copyright. So in order to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.



Notwithstanding sex workers' disproportionate risk of acquiring HIV (estimated HIV incidence in Niger's FSW in 2012 was 1.1%; 50–100 times higher than in women in the general population³³), prevention programs for sex workers accounted for a meager share of HIV prevention funding during 2007–2012 (NASA data). Internationally, it has repeatedly been pointed out that HIV allocations to FSW and other high-risk populations should be increased in alignment with the drivers of the epidemic.³⁴ Few studies have been able to recommend how much national HIV spending FSW interventions should receive, and what HIV impact could be expected at different levels of available budget. Our analysis, using a formal mathematical optimization approach and a detailed epidemic process model, provided actual allocation levels for Niger's FSW program and projected medium-term HIV incidence and DALY reductions associated with specific investment levels. It also projected the trade-off from shifting program resources away from low-risk populations. The recommended shifts in spending toward the FSW, ART, and PMTCT programs reflect the better targeting to populations among whom the majority of new HIV infections occur. In addition, these shifts emphasize the relatively high effectiveness of treatment-as-prevention because people living with HIV on treatment have significantly reduced infectiousness.²⁸

Our allocative efficiency analysis generated the type of evidence that countries need to make long-term investment decisions for a cost-effective and high-impact response. This is especially important in this decade, as external HIV funding is under pressure and countries are expected to contribute a fair share to their national HIV strategies. But, how can Niger make the money work better, if FSW programs do obtain a greater share of the HIV budget?

Lessons from India and Nigeria's sex worker HIV programs show that excellent "program intelligence" is a key to a well-targeted FSW program. Such intelligence must include current knowledge of the local-level epidemic dynamics and sources of new infections in specific populations, demographics,

and geographical zones.^{35–37} In Niger, our preliminary assessment showed that there is scope for improving and standardizing the FSW mapping and size estimation methodology across the regions and service providers. Additional effort is required to identify a higher proportion of the hidden FSW especially in areas where overt sex work is a cultural taboo. Also, mapping needs to be periodically repeated given the dynamics of hotspots, the shift toward electronic media for solicitation of clients, and the changing sociocultural context in the subregion shaping prostitution.

Using the 4 pillars of the program science approach,^{10–12} we identified with local stakeholders critical entry points for strengthening Niger's FSW strategy through external technical assistance: For better program intelligence, support for a quality protocol on programmatic and geographic mapping and size estimation is a priority, as is the quality assurance of the mapping activity itself through spot checks and during the data analysis stage. For improved program implementation and rollout, the assistance should provide guidance on the use of mapping data (clustering of implementation areas, linking of FSW sites to health centers with adequate capacity), and support the development of an implementation and monitoring manual. It should also foster participatory review activities, self-evaluation, and learning. Opportunities such as linkage with other sexual and reproductive health services should be harnessed for a more integrated approach to sex worker health.^{38,39} There should be increased condom provision to meet FSW demand. Importantly, simple standard operating procedures need to be developed in collaboration with providers from public, NGO, and private sectors, building on experience gained during SIDA-3, and referred to during repeat supervision and quality assurance activities.

Our modeling methodology has several limitations. First, we assumed that all changes in behavior are because of changes in program funding, and effects beyond the HIV epidemic were not considered (eg, wider effects of PMTCT within mother and child health, of condom use as a contraceptive, or effects of sex work interventions on sexually

transmitted infections and sexual and reproductive health). Second, because the analysis uses past ratios of expenditure to coverage as a basis for determining program costs, it does not build in future changes in cost which could arise if delivery modes, implementation arrangements, or technologies change. Third, the approach used to calculate relative cost-effectiveness between programs includes assumptions around the impact of increases or decreases in program funding. These assumptions are based on estimated unit costs and observed ecologic relationships between outcomes of program coverage or risk behavior and the amount of money spent on programs in the past and assuming that there would be some saturation in the possible effect of programs with increases in spending. The optimization results are quite sensitive to these relationships; in addition, because of the paucity of data (see the **Technical Appendix, Supplemental Digital Content**, <http://links.lww.com/QAI/A599>), it is difficult to even estimate uncertainties in these quantities because they are typically based on assumptions made in conjunction with in-country stakeholders rather than on data and statistical estimates. Fourth, the model necessarily simplifies both the populations and interventions. For example, the model does not separate clients of sex workers from the rest of the adult male population. Although this approximation works reasonably well when the prevalence of sex work clients among adult males is low, it becomes less valid the higher the prevalence of clients is and the greater the distinction is between clients and other males. Similarly, all KPs were combined into a single program for the purposes of optimization, whereas the interventions for MSM likely have a very different effectiveness than the interventions for other KPs. However, we do not have sufficient data to inform the parameters of this program and population to be able to meaningfully model this independently. Finally, our approach does not factor in equity or human rights dimensions. However, based on the use of Optima in Niger and about 14 other countries, and triangulation of outputs with other models, we believe that the Optima model reflects the epidemic dynamics and consequences of allocative decisions.

In summary, based on the presented evidence, Niger's FSW interventions seem to offer significant scope for increasing in scale, coverage, and impact with more resource allocation. Priority areas of technical support are now being developed with local stakeholders to tailor a focused technical assistance package to Niger's HIV interventions among sex workers. This is part of a larger collaborative support project in West and Central Africa by World Bank, UNAIDS, and USAID that includes regional training courses and country-level technical assistance. The overall aim is to assist governments to improve the efficiency and effectiveness of their targeted HIV interventions and hence contribute to the long-term sustainability of the HIV response in this subregion.

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